

130X-1

INTROUCTION TO ARC WELDING

AG 130-X

UNIT OBJECTIVE

After completion of this unit, students will be able to operate an arc welder safely, understand the AWS electrode classification, and demonstrate different arc welding skills. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Pass a safety test and demonstrate proper use of arc welding equipment.
2. Strike and maintain an arc correctly.
3. Be familiar with the American Welding Society (AWS) classification for electrodes.
4. Be familiar with the American Welding Society (AWS) basic blueprint reading for welds
5. Identify four basic weld joints and demonstrate the application of each in the flat position, using AC and DC equipment.

ARC WELDING EQUIPMENT AND SAFETY

A. Introduction to Arc Welding

1. An arc welding machine joins two metals together by generating an electric arc between a coated metal electrode and a base metal. The heat of the electric arc melts the metal which mixes with the molten deposits of the coated electrode. The coating of the electrode produces a gas which shields the weld from the atmosphere and helps to maintain the weld shape. This coating is later removed in the form of slag. The slag coating over the weld insulates the hot weld from contaminants in the air during cooling.

B. Equipment Used in Arc Welding

1. Power Supply

- a. The power supply of the arc welding apparatus must maintain a relatively constant current with only a slight change in voltage.
- b. Varying voltage and current will result in an uneven arc that creates splatters and uneven welds.
- c. There are three main types of power supplies.

1) Generators

- a) Generator powered arc welding machines run on direct current.
- b) These welding machines are commonly used in industry and are noisy, expensive to purchase, and costly to operate.

2) Transformers

- a) These machines are generally the cheapest to purchase and run on an alternating current.

3) Rectifiers

- a) The rectifier is a more versatile arc welding power supply that can be run on either direct or alternating current.

2. Ground Clamp

- a. The ground clamp completes the full electrical circuit so that enough heat will be available for the welding job.
- b. The ground clamp must be securely fastened to the metal being welded or to an adjoining workbench or piece of metal.

3. Electrode Holder (or Stinger)

- a. The stinger receives the amperage and directs it through the electrode to form the arc.
- b. The electrode holder should be well insulated, have a strong spring to firmly grasp the electrode, and a release lever to exchange the electrodes easily.

4. Cables

- a. The cables allow both the ground clamp and the stinger to be mobile.
- b. The cables should also be well insulated and protected from the heat during welding.

5. Electrode

- a. The electrode consists of an internal metal core and an outer coating called flux which shields the weld. The core melts into the molten base metal to produce the metal bond.
- b. There are several types and sizes of electrodes. Each will be discussed in detail in the next lesson.

C. Protective clothing must be worn at all times when welding. The heat created during arc welding creates flying molten sparks and ultraviolet and infrared rays that can burn the skin.

1. Leather Gloves

- a. Gloves protect the hands from burns during welding.
- b. The gloves should be made of thick leather and have long cuffs to protect the wrist and prevent sparks from falling into them.

2. Leather or Cotton Sleeves

- a. A NONFLAMMABLE material should be worn on the arms to protect from burns due to sparks and intense heat.

3. Body Protection

- a. Either a leather apron or coveralls or workshirt made of a flame retardant material will protect the body during arc welding.
- b. All protective clothing should fit properly and be free of openings or rips into which a spark might enter or the intense heat might penetrate.

4. Footwear.

- a. Leather boots should be worn while arc welding.
- b. Never wear open-toed shoes while working with hot metal or a welding apparatus.

D. Arc Welding Helmets and Shields - The brilliant light given off by the electric arc produces invisible ultraviolet and infrared rays which can severely burn the eyes and skin. NEVER LOOK AT THE ARC WITH THE NAKED EYE. Helmets and shields are equipped with special filtered lenses that reduce the intensity of the light and prevent the ultraviolet and infrared rays from reaching the eyes.

1. The welding helmet is designed specifically for the purpose of arc welding.
 - a. The welding helmet fits on the head using a plastic adjustable headband.
 - b. The helmet leaves both hands free for working and positioning materials.
 - c. Many helmets have clear lenses under the filtered lenses that can be used when chipping slag.
2. The hand shield is used for observing.
 - a. It is NOT advisable to use the hand shield when welding since one hand must be used to hold the shield in place.
3. The protective lenses come in different shades depending on the type of welding to be done. Different types of welding use different amounts of voltage and current which determine the intensity of the light and the amount of ultraviolet and infrared rays produced. Spot welding requires the fewest amperes and thus requires the least amount of shading in the lens. Arc welding machines require from less than 30 to over 400 amperes. Lens shades range from number 5 (which provides the least amount of protection) to shade 14 (which provides the most protection).

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- a. Shade 5 is used for light spot welding.
 - b. Shades 6 and 7 are suitable for welding with up to 30 amperes.
 - c. Shade 8 is for welding with 30-75 amperes.
 - d. Shade 10 can be used when welding with 75-200 amperes.
 - e. Shade 12 is used when welding with 200-400 amperes.
 - f. Shade 14 is required when welding with over 400 amperes.
4. Cover glasses are clear lenses that are used to stop flying slag or metal, thus protecting the filter lenses. There are 3 different types of cover glass currently available.
 - a. Clear, unbreakable plastic is the cheapest and lasts the longest.
 - b. Chemically treated glass is used to reduce pitting but it can be expensive.
 - c. Plain glass is very susceptible to breaking, pitting, and splatter sticks and is NOT recommended.
5. Filter lenses must be changed if a crack or chip occurs in order to prevent ultraviolet and infrared rays from reaching the eyes. The shades of the lenses must also be changed. If the shade is too dark, the worker will be unable to see the work that is being performed. If the shade is too light, proper eye protection is not achieved. Many welding helmets have interchangeable lenses. The lens changing procedure is as follows:
 - a. Remove the lift-up mechanism on the helmet or the lens frame lock.
 - b. Slide the old filter lens out and insert the new one.
 - c. Reinsert the lift-up mechanism or the lens frame lock.
 - d. Put the helmet on and search for light leaks. If leaks are present, the lens must be readjusted.

E. Additional Welding Equipment

1. Goggles - Goggles must be worn when chipping slag if a shell lens is not provided in the helmet. NEVER CHIP SLAG WITHOUT PROTECTIVE EYEWEAR.
2. Tongs - The heat of the arc will heat all of the metal being welded. Always use tongs to carry or maneuver the metal stock.
3. Slag Hammer or Chipping Hammer - The slag hammer is used to remove slag from the weld for proper cooling.
4. Wire Brush - If a second pass is to be made with the arc, the wire brush must be used to remove all slag fragments from the welding area. If not removed, the weld will not be solid and residual stresses will result.

C. Safety in Arc Welding

SAFETY IN ARC WELDING

When arc welding, observe the following general safety practices.

1. Wear gloves and eye and face protection. The welder and all observers must wear welding helmets with a No. 10 or 12 filter lens. A welding cap or helmet with a hard hat is also recommended for head protection. When chipping slag or cleaning welds, wear a clear face shield or flip-up liftplate on the helmet.
2. Avoid electrical shock. Make certain that the electrode holder and all electrical connections and cables are properly insulated. Check to see that the welder is properly grounded. Do not dip the electrode holder in water to cool it because this practice may result in electrical shock.
3. Protect others. For small and practice welding jobs, work in a partitioned area to protect others from harmful rays. When prepared to strike the arc, inform all bystanders to cover their eyes.
4. Never weld in a damp area. Stand on a dry board or rubber mat if the floor or ground is damp or wet.
5. Never wear synthetic fiber clothing. Synthetic fibers are highly flammable. Wearing clothing made from wool or cotton is more satisfactory for welding because of their relatively high flash points.
6. Protect welding cables. Keep the cables from coming in contact with hot metal and sharp edges. Do not drive over cables. When welding, avoid wrapping electrode cables around your body.
7. Secure work. Use a welding table with a positioner to hold welds securely in place. Clamps and vises can be used to hold odd-shaped work or field work. Securing work will also prevent injury from accidental dropping of metal on your feet or body.
8. Dispose of electrode stubs properly. Keep a container in the work area in which to deposit electrode stubs. This prevents burns to shoes or falls due to stubs rolling underfoot.
9. Prevent burns. Never allow the hot electrode or electrode holder to touch bare skin. Avoid letting the electrode touch a grounded cable. Remove hot metal from the work area when you are finished welding to prevent burns to others.
10. Do not let the electrode stick. If the electrode sticks, cut off the switch, allow the electrode to cool, and then break it loose with your gloved hand.
11. Use both hands. To reduce fatigue, use both hands for welding.
12. Handle hot metal with pliers or tongs. Submerge hot metal completely in water to prevent steam burns.

13. Weld in a well-ventilated area. The fumes from lead, zinc, cadmium, and beryllium are toxic and may cause sickness or death.
14. Do not carry matches or lighters, and do not allow bystanders to smoke. Before welding, make sure the welding area is free of other flammables (gas, grease, etc.).

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ACTIVITY:

1. Practice changing lenses and head gear in arc welding helmets.
2. Practice identifying and handling arc welding equipment, making sure that all safety procedures are followed and that suitable clothing is being worn.

STRIKING AND MAINTAINING AN ARC

A. Setting, Checking, and Adjusting the Equipment

1. Equipment adjustment for proper amperage is vital for arc establishment.
 - a. To start the welding operation make sure that the electrode holder and ground clamps are clean and in good condition. Inspect the cable connection to make sure they are tight and that no exposed wires are present.
 - b. The welding bench should be clean and dry.
 - c. The ground clamp should be attached to the welding bench in a secure manner.
 - d. If using D.C. polarity, it is important that the machine is set for straight or reversed current
 - e. The next step is to select the proper amperage. Tentatively determine the recommended current setting for the type and size of electrode to be used; make the final adjustment after the actual welding operation has been started. The electrode selection chart gives both a low and a high setting choice. A current value midway between the two limits is recommended. The following electrodes are recommended for this exercise: E6010, E6011, E6012, E6013 or E7014.

NOTE: Some instructors like to use E-6013 and E-7014 rods because they strike and hold an arc easily and beginning welders build confidence. However, others feel that changing back to a E-6011 type rod is more difficult and they prefer to start with a fast-freeze rod of E-6011 type. It is also suggested that you use 1/8" or 5/32" electrodes for this exercise (see electrode selection chart in the addendum).

B. Striking an arc

1. Select a plate or coupon of steel 1/4" thick, 3" to 5" wide, and 6" to 10" long.
 - a. There are two methods that can be used to start or strike the arc: a tapping or a scratching motion. The tapping method is the one that experienced welders use, whereas the scratching motion method is generally easier for the beginner.
 - 1) The scratching motion method requires that the electrode be brought down at an angle to the plate very similar to scratching a match. When the arc is started (flashes) the electrode must be quickly raised so that it will not stick to the base metal.
 - 2) The tapping method requires that the rod be held directly above the work. The rod is brought down and touches on the base metal. As the arc strikes, the rod must be quickly brought up to approximately the thickness of the electrode or the rod will stick to the base metal.
 - 3) If the rod sticks to the base metal, the current flow will cause the rod to become very hot. To remove a stuck electrode from the work, use a quick twisting or striking motion of the electrode holder. If this does not break the electrode loose, remove the electrode holder from the grip end of the electrode. Since this electrode is red hot, use pliers to twist it loose.
 - b. Practice striking and stopping the arc until this action can be completed quickly and easily.
 - 1) A good practice coupon can be laid out in a grid pattern with center punch mark 1/2" apart. Practice starting the arc on each of these marks.
2. Practice running beads after the skill of striking and maintaining an arc has been mastered.

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- a. Stringer beads are an excellent bead for beginning welders to make. The beads will not be consistent but should improve with practice.
 - b. The beginning welder can practice with different electrode settings, arc lengths, electrode angles, and speeds until a smooth, strong weld is produced.
 - 1) Welding done with proper amperage, voltage, and speed displays
 - a) Good penetration
 - b) No undercut or overlay
 - c) Smooth appearance
 - 2) If the arc is too long, there is:
 - a) Poor penetration, overlap, spatter
 - b) Leaves weld puddle exposed to oxidizing air
 - 3) If the welding current setting is too high, there is:
 - a) Spatter and undercutting
 - b) A deep crater
 - 4) If the welding current setting is too low, there is:
 - a) Poor penetration with high narrow bead
 - b) Not enough current to fuse weld to metal
 - 5) If the welding speed too fast, there is:
 - a) Irregular bead with skips
 - 6) If the welding speed too slow, there is:
 - a) Bead too high, somewhat irregular and porous
 - b) Builds up too much metal and metal stays melted too long
3. After mastery of the stringer bead, practice oscillation, which entails keeping the tip of the rod weaving back and forth across the molten weld pool.

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- a. The weaving motion of the electrode keeps the molten metal pool agitated; this helps float the slag and impurities to the top so they can be removed by chipping and brushing and it also helps to reduce porosity within the weld bead area.
- b. The weave bead also can be used to give a wide coverage (cover pass) for the weld joint.
- c. The weave bead will improve penetration and thicken pieces of weld plate.
- d. The basic weave bead is a crescent-shaped zigzag.

1) Hesitate at sides to prevent undercutting and to allow the bead to build.

2) Be sure to bond the weave to the material on each side.

4. There are various other welding patterns, for example, whipping motion, semicircular motion, circular motion, V-shaped motion, back and forth or N-shaped motion, U-shaped motion, figure-8 motion, and rotary motion.

5. Metal Preparation

- a. Cut a plate approximately 4" X 5" X 1/2"
- b. Brush and clean plate
- c. Mark 4 lines 1/2" apart down the 5" length
- d. Run a stringer bead down each line with 1/8" rod
- e. Chip and clean stringer beads

6. Weaving Exercise

- a. Weave beads between stringers to cover plate with smooth weld
- b. Fuse the weave into the stringers
- c. Chip, clean, and evaluate work

ACTIVITY:

- 1. Strike and maintain an arc by building up a small boss on each center punch mark on coupon
- 2. Explain what happens when an arc is being maintained.
- 3. Start and restart the electrode at different places on the coupon.
- 4. Run and evaluate stringer bead for correctness.
- 5. Run and evaluate weave beads.

AWS CLASSIFICATION SYSTEM FOR ELECTRODES

A. What are electrodes and how are they selected for various welding applications?

1. Shielded electrodes are thin metal rods having approximately the same composition as the metal to be welded. They are coated with a wide variety of types of flux.
2. Electrodes are designed not only to weld different metals but also to use AC, DC reverse, or DC straight polarity electric current.
3. Electrodes come in various diameters; the larger the diameter the higher the amperage required to properly use the electrode.
4. It is very important that the appropriate electrode be selected for a given welding operation. Poor electrode selection will cause difficulty in completing a good welding job.
5. Electrodes are classified into five main groups:
 - a. Mild steel
 - b. High-carbon steel
 - c. Special alloy steel
 - d. Cast iron
 - e. Non-ferrous

B. The American Welding Society (AWS) has developed the following electrode classification system:

1. What does the classification E-7018 on an electrode mean? Reading from right to left.
 - a. The right-hand digit (8) indicates the special characteristics of the electrode, such as type and general content of the coating, weld quality, amount of penetration, and the type of arc or electrical current. The right-hand-digit may be any number between 0 and 8. It is important to note that the right-hand digit cannot be considered individually but must be considered in conjunction with the second digit from the right in order to identify both the polarity and position of the electrode.
 - b. The second digit from the right (1) indicates the positions the welding electrode can be used. This digit may be any number between 1 and 4.
 - 1) 1 indicates the electrode can be used in all positions; flat, horizontal, vertical, and overhead.
 - 2) 2 indicates the electrode can be used in flat or horizontal positions.

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- 3) 3 indicates the electrode should only be used in the flat position.
 - 4) 4 indicates the electrode can be used for vertical down welds only.
- c. The two or three digits to the left (70) indicate the tensile strength in thousands of pounds per square inch (i.e., 70 means 70,000 psi).

C. Selecting the correct Electrode

1. The electrode should produce a weld metal with approximately the same metallurgical properties as the parent metal. A top quality weld should be as strong as the parent material.
2. In selecting the best electrode for a particular welding situation, the aim is to choose one that will provide good arc stability, fast deposition, maximum weld strength, minimum splatter, easy slag removal, and a smooth weld bead. To achieve these characteristics from an electrode, the following factors should be considered:
 - a. Electrode Diameter – Generally, an electrode with the diameter larger than the thickness of the base material should not be used. If this is done, welding must be done at a very high rate of speed and this requires considerable skill in order to obtain a sound weld. When making a vertical or overhead weld, a fast freeze type electrode with the diameter of 1/8" would normally be used. Regardless of the base metal size, an electrode diameter of 3/16" is the maximum size used. Electrode diameter is also determined by the joint design such as a joint with narrow gap or V-groove base metal plates. When this is a factor, use a small diameter electrode to do the root pass or the first weld bead.
 - b. Joint Design – This is another important factor to consider when choosing an electrode.
 - 1) When welding a joint that is not beveled at the proper angle to allow easy penetration, consider using a deep penetrating, fast freeze electrode, for example, E-6010 or E-6011. The opposite of this situation would be an open or poorly fit joint where a good choice of electrode is E-6012 or E-6013.
 - c. Welding Position – The welding position to be used during the deposition of the weld metal is a very important factor when selecting an electrode.

- d. Type of Welding Current – This is another factor to consider when choosing an electrode. Some electrodes are designed for AC and DC straight or DC reverse polarity while others are designed to function properly using either AC or DC current. Information regarding current is generally written on the outside of the package and does not have to be figured from the AWS classification number.

ACTIVITY:

1. Select six different arc electrodes and outline in writing each of their characteristics.
2. Weld a bead with each of the six arc electrodes and describe in writing how each electrode reacts during the welding process.
3. Weld various beads using DC straight, DC reverse, and AC type currents.

FOUR BASIC WELDS

A. Welding a Bead

1. A weld is known as a bead, made by one pass of an electrode.
2. Welding a bead is the first step after striking an arc and towards making other types of welds.
3. Stopping and restarting a bead in the middle of a weld should be practiced. Due to the fact when you run out of an electrode you will need to restart with a new one.
4. Set welding amperage to desired setting (depending on the electrode and the thickness of metal used.)
5. Keep arc length between 1/16" – 1/8", listen to it (sounds like frying bacon) and keep it constant.
6. Angle the electrode 15° – 20° from vertical towards the direction of travel. At the same time keep the side to side angle at 90°.
7. Speed of travel, watch the width of the puddle and keep it constant.

B. Butt Weld

1. The butt joint is one of the most frequently used weld joints.
 - a. A butt joint consists of placing the edges of two pieces of metal together.

2. The butt joint is used when structural pieces have a flat surfaces, for example, tanks or flat decks, and when laminating pieces for machine parts.
3. There are three types of but joints: closed, open, and when laminating pieces for machine parts.
4. The closed butt should be used only if the material to be welded does not exceed 1/8" to 3/16" in thickness.
5. When using the open butt, the joints are spaced 3/32" to 1/8" apart.
6. When the material to be welded exceeds 3/16" in thickness, the butt joint should be beveled. There are three types of bevel or V joint designs:
 - a. In a feather edge, the material is 1/8" to 3/16" thick, the bevel is 60 degrees and the bottom edges of the material are placed together.
 - b. The shoulder edge is used for materials 1/4" or more thick; 1/16" to 1/8" of the bottom of the material is not beveled and a gap of 1/8" is allowed for the root pass.
 - c. The double V is used for material over 3/8" thick. This V joint has a 60 degree bevel; however, a 3/32" to 1/8" face is left in the lower 1/3 of the weld joint. This root face is generally spaced 1/8" apart for proper root pass operation.
7. If the bevel on any groove joint is greater than 60 degrees, it is difficult to limit and control the amount of contraction when the metal cools.
8. A backup strip should be used in an open butt joint in order to prevent excessive burn-through.
9. A round stock weld is a variation of the butt joint weld.
 - a. In order to weld rods or round solid shaft material, both ends of the stock must first be beveled, leaving a shoulder in the center. The edges should be ground so they have the same angle

C. Pad Welding

1. A pad weld is used to build up metal surfaces after it has been worn down.
2. Pad welding can be done on flat or round surfaces.
3. Pad welding consists of depositing several layers of beads.
 - a. Welding a bead to cover half of the previous bead.
 - b. Welding beads one over the top of another

4. Angle the electrode $15^{\circ} - 20^{\circ}$ from vertical towards the direction of travel. At the same time keep the side to side angle at 90° for the first pass. For the second, third, etc. hold the electrode $10^{\circ} - 15^{\circ}$ from vertical.

D. Fillet Weld (Tee Joint)

1. The tee joint is formed by placing one plate at a 90 degree angle to another to form a letter T. A tee joint is a Fillet-type weld.
 - a. The tee joint is weak and should not be used if heavy pressure will be applied from the opposite direction of the welded joint.
 - b. There are several types of fillet joints. The basic fillet welds for tee joints are classified as square, single bevel, double bevel, single J and double J.
 - 1) The square tee is used where the material can be welded on one or more side. Considerable weld metal is required for maximum strength.
 - 2) The single bevel tee is used on material that is less than 1/2" thick. This joint will withstand more severe loading than the square tee, where welding can be done from one side only.
 - 3) The double bevel tee is used where heavy loads are applied in all directions and where welding can be done on both sides.
 - 4) The single J joint is used on material 1 1/2" and thicker and can be welded from both sides.
 - c. To start a practice fillet, use 3/16" to 1/4" thick material. Set the vertical plate on the middle of the flat plate and tack weld each end. Then start the main weld. On material of this thickness, a single pass (which is one layer of a weld bead) should be sufficient.
 - d. The angle of electrode is very important. The best results are obtained by holding the electrode at 45 degrees between the vertical bottom flat plate with the tip pointed toward the weld area. The direction of travel will have a $15^{\circ} - 25^{\circ}$ angle in the direction of travel. This first single pass bead should be a 1/4" fillet.

ACTIVITY:

1. Prepare and weld each of the four types of welds.
2. Design and build a project utilizing at least three different types of welds.

References:

Burke, Stanley R., & Wakeman, T. J. (1990). MODERN AGRICULTURAL MECHANICS (2nd ed.). Danville, IL: Interstate Publishers.

Cooper, Elmer L. (1997). AGRICULTURAL MECHANICS: FUNDAMENTALS AND APPLICATIONS, 3rd EDITION. Albany, NY: Delmar Publishers.

Special Material and Equipment:

Arc welding helmet, leather gloves, aprons, coveralls, strikers, safety test, slag hammer, safety goggles

Resources:

Deere & Company. (1987). WELDING (6th ed.) (Fundamentals of Service (FOS) Series). Available from: John Deere Technical Services, Dept. F, John Deere Road, Moline, IL 61265 (Available in Spanish)

Giachino, Joseph W., & Weeks, William (1976). WELDING SKILLS AND PRACTICES (5th ed.). Available from: American Technical Society, Chicago, IL 60637
Hobart Brothers Company. (1978). TECHNICAL GUIDE FOR SHIELDED METAL ARC WELDING. Available from: Hobart Brothers Company, Troy, OH 45373

Name _____

Date _____

Score _____

UNIT EXAM, ARC WELDING

Multiple Choice, circle the letter that best represents the correct answer.

Short answer

1. Which of the following is not a type of welding power supply?
 - a. Rectifier
 - b. Transformer
 - c. Alternator
 - d. Generator
2. What is the purpose of the ground?
3. The flux of an electrode
 - a. forms a gas
 - b. creates slag
 - c. forms a shield for the weld
 - d. all of the above
4. The best material to use for protection clothing , footwear, and gloves is
 - a. nylon
 - b. leather
 - c. polypropylene
 - d. dacron
5. The darkest and most protective lens available for welding purposes is
 - a. Shade 5
 - b. Shade 7
 - c. Shade 10
 - d. Shade 20
6. The ground clamp should be attached to
 - a. a non-conductive block of wood
 - b. the project or worktable
 - c. a properly grounded bolt mounted in the floor
 - d. the electrode

7. A weld with the proper amperage, voltage, and speed displays
 - a. good penetration
 - b. no undercut or overlay
 - c. a smooth appearance
 - d. all of the above
8. When the voltage setting is too low, the weld
 - a. spatters and undercuts
 - b. digs a deep crater
 - c. leaves the weld puddle exposed to oxidizing air
 - d. provides poor penetration with a high, narrow bead
9. What is the tensile strength of an electrode marked E6013
10. What does the E represent on an electrode marked E6011
11. What does the third and fourth digits represent on an electrode marked E7018

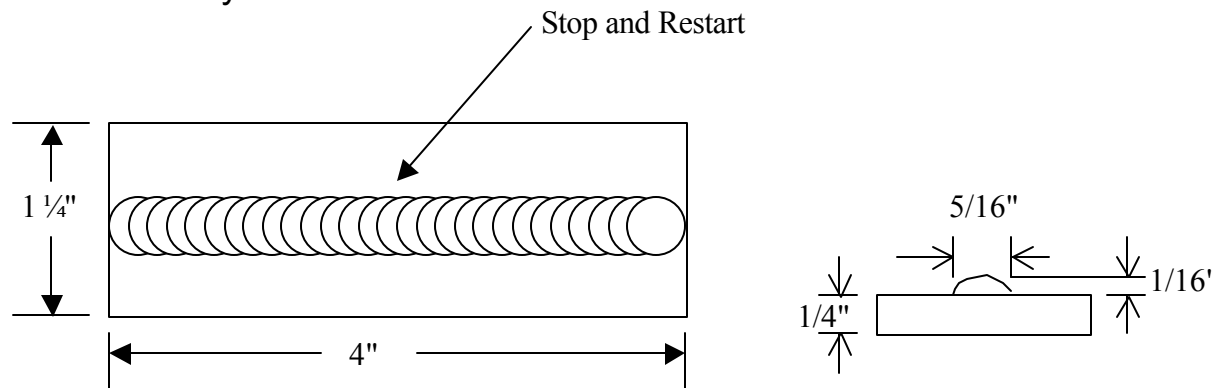
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Answer Sheet

1. C
2. Completes the full electrical circuit
3. D
4. B
5. C
6. B
7. D
8. D
9. 60,000lbs of tensile strength per inch of weld.
10. Electrode
11. The third digit indicates the position the rod can be used in and the fourth indicates the characteristics of that rod, 1 means all positions and the 8 means low hydrogen.

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Arc Welding, Bead

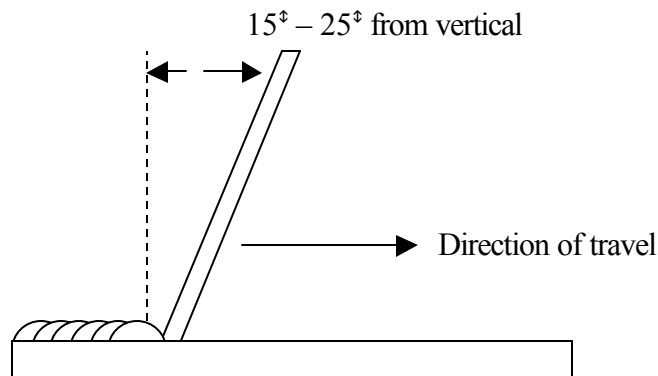
1. Use 1/8" E6013 electrode.
2. Use 1/4" x 1 1/4" 4" metal.
3. Stop completely and restart in middle of weld.
4. Fill in crater at the end of bead.
5. Clean the weld with wire brush.
6. Weld one side only.



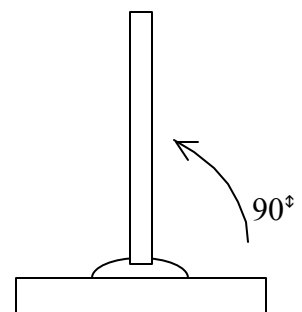
Variables that influence the bead:

1. AMPERAGE Use middle range from chart & adjust from there.
2. ARC LENGTH Usually 1/16" – 1/8" Listen to it (frying bacon)
Keep it constant.

3. ANGLE OF ELECTRODE



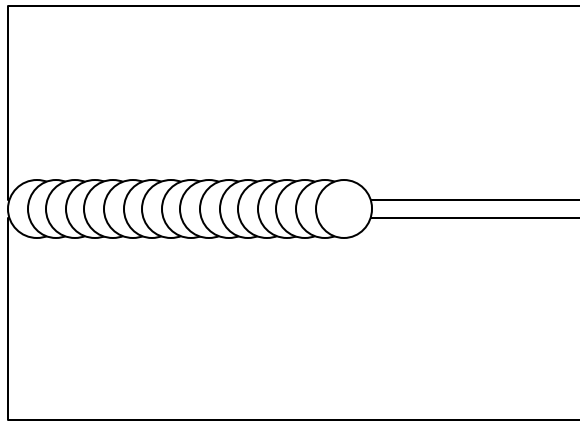
END VIEW



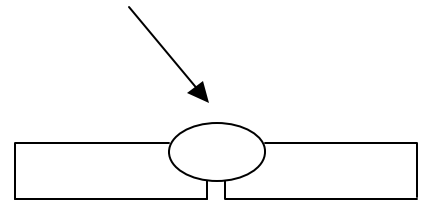
4. SPEED OF TRAVEL Watch the width of puddle – keep it constant
5. ELECTRODE

Arc Welding, Butt Weld

1. Use 1/8" E6013 electrode.
2. Use two pieces of 1/4" x 1 1/4" 4" metal.
3. Bead with equal length on both sides of the joint.
4. Fill in crater at the end of bead.
5. Clean the weld with wire brush.
6. Weld one side only.

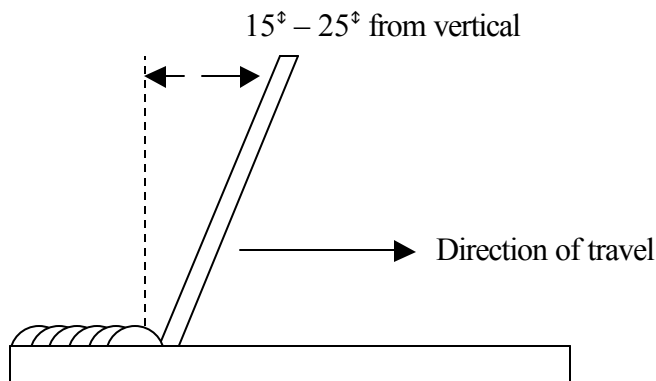


Equal length on both sides

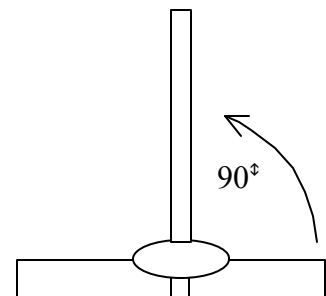


1. AMPERAGE Use middle range from chart & adjust from there.
2. ARC LENGTH Usually 1/16" – 1/8" Listen to it (frying bacon)
Keep it constant.

3. ANGLE OF ELECTRODE



END VIEW

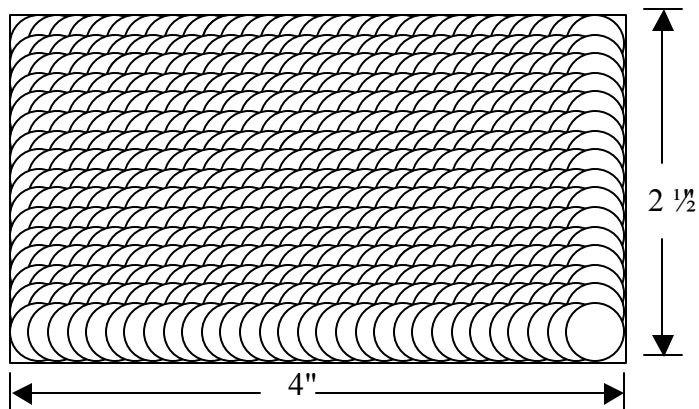


4. SPEED OF TRAVEL Watch the width of puddle – keep it constant
and even on both sides
5. ELECTRODE

Arc Welding, Pad Weld

1. Use 5/32 E6013
2. Use 4" x 2 1/2" x 1/2" metal
3. Cover entire surface of the plate with overlapping welds.
4. Cover half of the previous bead.
5. Cool between beads only until red color is gone

TOP VIEW



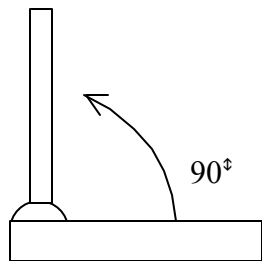
END VIEW



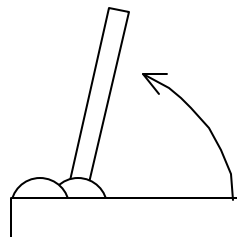
WRONG



RIGHT



First Pass



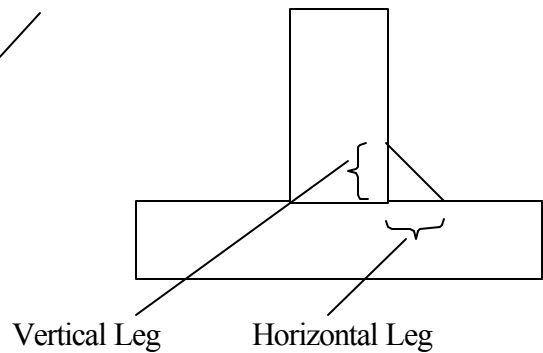
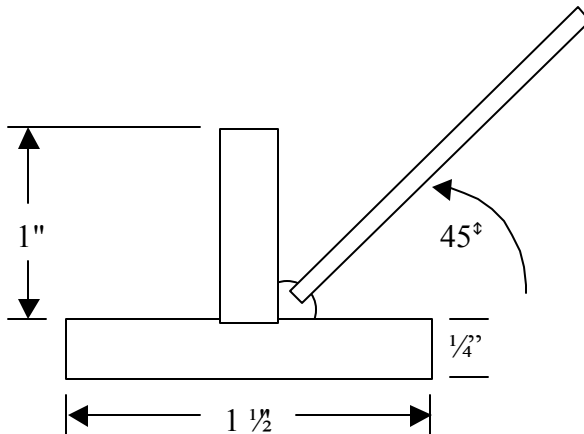
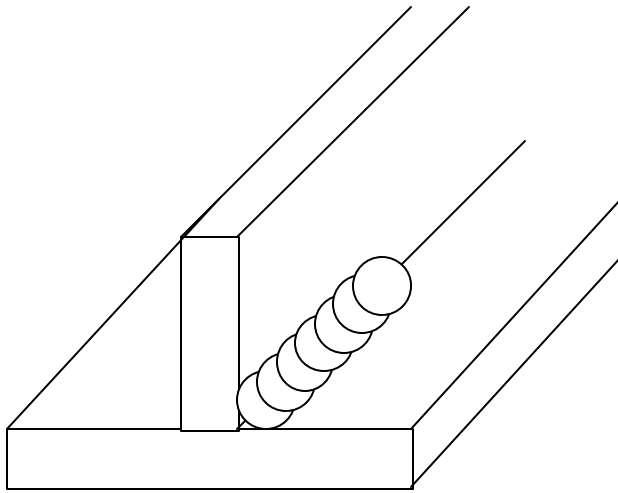
Second Pass, etc.

10° – 15° from vertical

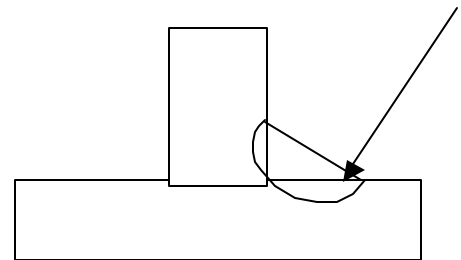
6. Finished surface to be as flat as possible.

Arc Welding, Horizontal Fillet

1. Use 1/8" E6013 electrode.
2. Use 1/4" x 1 1/2" x 4" metal for the base.
3. Use 1/4" x 1" x 4" metal for the upright.
4. Use a short arc length.
5. Hold the electrode at a 45° angle from the base plate.
6. Hold the electrode at a 15° – 25° angle in the direction of travel.
7. Horizontal and vertical legs need to be **equal**.



Unequal Legs, Unequal Penetration



Undercutting Caused by:

1. Too long of an arc.
2. Electrode too straight up and down.
3. Too much amperage.
4. Using motion.
5. Too much lead angle.